IV. RESULTS OF CANCER INCIDENCE ANALYSIS

The following sections present cancer incidence rates for Wayland as a whole and for each census tract evaluated. Analysis by census tract or smaller geographic area helps in understanding whether the incidence of cancers observed town-wide may be explained by an increase or decrease in cases in a particular geographic area of the town. Section A presents results of cancer incidence analysis in Wayland for the years 1982-1992. Section B presents results of cancer incidence analysis in Wayland for the years 1987-1994 and 1995.

A. Results of Cancer Incidence Analysis in Wayland 1982-1992

Tables 1A through 3B summarize the cancer incidence data town-wide and for each census tract for three different time periods: 1982-1992, 1982-1986 and 1987-1992.

1. Cancer Incidence for Wayland as a Whole (Tables 1A & 1B)

During the 11-year period 1982-1992, cancer incidence in the town of Wayland occurred generally less often than expected. An elevation in pancreatic cancer was observed among males (10 cases observed versus 6.1 cases expected). This elevation was not statistically significant. Lung cancer occurred significantly less often than expected among males. Thirty-seven cases
occurred during the 11 years 1982-1992 where 53 cases were expected (SIR=70; 95% CI=49-97). Females experienced slight elevations in cancers of the lung and breast as well as leukemia and NHL. Elevations observed in these cancer types were based on a small number of excess cases (i.e., about three or less) and were not statistically significant.

When examined by smaller time period, cancer incidence in Wayland also generally occurred less often or equal to expected rates. Pancreatic cancer was elevated among males during the earlier time period 1982-1986. Among males, six cases occurred versus

approximately three expected cases (SIR=214). This elevation was not statistically significant. During the later time period, the incidence of pancreatic cancer in males was about as expected. Among females, pancreatic cancer occurred less often than expected in both time periods. Among females, breast cancer was elevated during the earlier time period but occurred less often than expected during the later time period 1987-1992. One case of breast cancer occurred among males in Wayland during the later time period 1987-1992. Lung cancer and NHL were slightly elevated among females during the later time period. Neither of these elevations was statistically significant.

2. Cancer Incidence in Census Tract 3661 (Tables 2A & 2B)

During the period 1982-1992, cancer incidence in CT 3661 occurred at lower than expected rates among males, females and among males and females combined for most of the cancer types evaluated. Slight and non-significant elevations were observed in kidney cancer among males and in NHL among females (two excess cases in each cancer). An elevation in lung cancer among females nearly achieved statistical significance (20 cases observed versus 12.5 cases expected).

The incidence of bladder cancer and leukemia occurred approximately equal to or less than expected for all three time periods examined and for both sexes. In addition, liver cancer occurred approximately equal to expected rates. No cases of liver cancer occurred among females during the 11-year period 1982-1992. Stomach cancer occurred less often than expected during all three time periods examined and among both sexes.

Breast cancer was elevated during the earlier time period in this census tract. Twenty-one cases occurred while slightly more than 16 cases were expected (SIR=130; 95% CI=80-198). Breast cancer occurred less often than expected during the later time period 1987-1992 (17 cases observed versus 23 cases expected). One case of male breast cancer was observed in CT 3661.

Hodgkin's disease occurred equal to or less than expected during the entire 11-year period 1982-1992 and during the later time period 1987-1992. During the earlier time period, Hodgkin's disease was slightly elevated. The elevation was based on one excess case.

The incidence of kidney cancer occurred generally less than or equal to expected overall and among females during all three time periods evaluated. Among males, the incidence of kidney cancer was elevated during 1982-1992 mainly due to an elevation during the later time period 1987-1992. The elevation was based on an increase of two cases and was not statistically significant. Five cases were observed during 1982-1992 and three cases were expected (SIR=164).

The incidence of lung cancer was greater than expected among females during 1982-1992. Lung cancer was also elevated among females during both the smaller time periods 1982-1986 and 1987-1992. These elevations however were not statistically significant. Among males the incidence of lung cancer was less than expected during the earlier time period 1982-1986 and occurred more often than expected during the later time period 1987-1992.

NHL was slightly elevated among females but occurred less often than expected among males during 1982-1992. The elevations experienced among females were not statistically significant.

The incidence of pancreatic cancer occurred about as expected overall for the entire time period 1982-1992. During the earlier time period 1982-1986, a slight elevation was observed among males (3 cases observed versus 1.2 cases expected). During the later time period, pancreatic cancer occurred less often than expected among both males and females.

3. Cancer Incidence in Census Tract 3662 (Tables 3A & 3B)

Overall, during 1982-1992, most cancer types occurred less often than expected in CT 3662. Lung cancer occurred significantly less often overall and among males. A total of 20 cases

occurred among males where slightly more than 33 were expected (SIR=60; 95% CI=37-93). The incidence of leukemia and pancreatic cancer was increased but not significantly. The incidences of breast cancer and leukemia were mainly due to an increase observed among females. The increases were due to an excess of one or two cases and were not statistically significant. NHL was elevated among females. This elevation was not statistically significant. The elevation observed in NHL was based on increase of one case and was not statistically significant.

Bladder cancer was less than or equal to expected during all three time periods evaluated. An increase of one case occurred among males during the later time period 1987-1992. Both lung cancer and stomach cancer occurred less often than expected in each time period evaluated and for each of the sexes. Lung cancer occurred significantly less often among males and females combined during the later time period 1987-1992.

Breast cancer occurred less often than expected during the earlier time period but was elevated during the later time period 1987-1992. The elevation was not statistically significant.

No cases of Hodgkin's disease or liver cancer occurred in this census tract during the earlier time period 1982-1986. The incidence of Hodgkin's disease was less than expected during the later time period 1987-1992. One case of liver cancer occurred among males and one among females during 1987-1992.

With the exception of females during the later time period 1987-1992, the incidence of kidney cancer and NHL occurred less than or equal to expected rates during all three time periods evaluated. During the period 1987-1992, five cases of NHL occurred among females where approximately three cases were expected (SIR=277). This elevation was not statistically significant.

The incidence of leukemia occurred less often than expected among males during all three time periods examined. Females experienced a small increase in leukemia during 1987-

1992. Three cases occurred in this CT 3662 where slightly more than one case would have been expected. These three cases were of different histologic types of leukemia and occurred in individuals over the age of 55. This pattern is consistent with the epidemiology of leukemia, and does not suggest an unusual pattern.

Pancreatic cancer occurred less often than expected among females during all three time periods. However, the incidence of this cancer was slightly elevated among males in each of the time periods evaluated. During the period 1982-1986, three cases occurred where approximately two cases were expected. During the later time period 1987-1992, four cases occurred where approximately two cases were expected. None of the observed increases were statistically significant.

B. Results of Cancer Incidence Analysis in Wayland 1987-1994 and 1995

Tables 4 through 6 summarize the cancer incidence data town-wide and for each census tract for the time period 1987-1994.

1. Cancer Incidence in Wayland as a Whole (Table 4)

During the entire time period 1987-1994, cancer incidence in the town of Wayland generally occurred at or near the expected rates. In fact, most cancer types evaluated occurred at approximately the same rates observed during the 1987-1992 time period.

During the previous investigation (1987-1992), pancreatic cancer among males occurred about as often as expected (four cases observed versus approximately three expected). During 1987-1994, male pancreatic cancer also occurred about as often expected (five cases observed versus approximately five expected).

Although female breast cancer occurred less often than expected during 1987-1992, the incidence of female breast cancer occurred more often than expected during 1987-1994.

Eighty-one cases occurred during the eight year period when approximately 75 were expected (SIR=108). This elevation was not statistically significant.

Lung cancer incidence during the 1987-1994 time period was consistent with what was observed during the 1987-1992 time period. During 1987-1994, lung cancer among males occurred less often than expected (32 cases observed versus approximately 43 expected). Among females, lung cancer was slightly elevated; thirty-one cases were observed where approximately 27 were expected. Among males and females combined, lung cancer occurred less often than expected; 63 cases occurred when approximately 70 cases were expected (SIR=90). This observation was largely due to the pattern observed among males.

Among females, NHL occurred slightly more often than expected (11 cases were observed where approximately seven were expected). This elevation is due to an excess of approximately four cases and is similar to the pattern observed among females for the 1987-1992 period. During 1987-1994, the incidence of all other cancer types occurred less than or about as expected, based on the statewide experience.

It should be noted that upon re-evaluation of the incidence of Hodgkin's Disease for the years 1987-1992, a previous data entry error was discovered. During the time period 1987-1992, the state observed number of cases used to calculate the SIR resulted in an overestimate of expected numbers of cases in Wayland (i.e., 6.2 expected cases vs. 2.6 expected cases). This error was corrected for the 1987-1994 analysis and did not significantly change results. Overall, during 1987-1994, Hodgkin's Disease generally occurred about as often as expected.

In 1995, a total of 25 new cases of cancer (different types) occurred in Wayland. One additional case was reported for cancers of the bladder, kidney and pancreas; all occurred among males. In addition, two cases of NHL, three cases of stomach cancer, and thirteen cases of female breast cancer were observed. Four new cases of lung cancer were diagnosed in 1995, two of these cases

occurred among males, and two occurred among females. No cases of leukemia, liver cancer or Hodgkin's Disease occurred among Wayland residents in 1995.

2. Cancer Incidence in Census Tract 3661 (Table 5)

A similar pattern of cancer incidence was observed for the years 1987-1994 in CT 3661 as was observed during the 1987-1994 time period. During the eight-year time period, elevations were observed in two of the ten cancer types evaluated; lung cancer and NHL. NHL occurred more often than expected among males in CT 3661. Five cases were observed when approximately three were expected. In addition, lung cancer was statistically significantly elevated among females. Nineteen cases were observed when 11 were expected. (SIR=172; 95% CI=104-269). The remaining eight cancer types evaluated occurred less than or approximately equal to the expected rates.

In 1995, eight new cases of cancer (different types) were diagnosed among residents in this census tract. One case was observed for cancers of the bladder, lung and NHL. Three cases of female breast cancer occurred and two cases of stomach cancer were also reported. No cases of cancers of the kidney, liver, pancreas, leukemia or Hodgkin's Disease occurred in 1995 in CT 3661.

3. Cancer Incidence in Census Tract 3662 (Table 6)

During the time period 1987-1994, most cancer types in CT 3662 occurred at or near the expected rates. Breast cancer occurred more often than expected among females. Fifty-six cases were observed where approximately 44 were expected. This is similar to the pattern observed during 1987-1992. This elevation was not statistically significant. NHL occurred slightly more often than expected among females in this census tract. This elevation was based on an excess of two cases. A total of six cases were observed and four were expected (SIR=148).

Lung cancer occurred statistically significantly less often than expected among males, and among males and females combined. Overall, 29 cases were observed when approximately

44 were expected (SIR=66). No new cases of male pancreatic cancer were diagnosed during the 1987-1994

time period, and all other cancer types evaluated occurred about as often as expected (i.e., no more than one or two excess cases) or less than expected.

Evaluation of the most recent cancer incidence data for the year 1995 indicates that 17 additional cases of cancer (different types) were reported among residents of CT 3662. One case was observed for cancers of the kidney, pancreas, stomach and NHL. Ten cases of female breast cancer occurred and three cases of lung cancer were also reported. No cases of bladder cancer, liver cancer, leukemia or Hodgkin's Disease occurred.

C. Evaluation of Geographic Distribution

Place of residence at the time of diagnosis was mapped for all cancer types to assess any possible geographic pattern of cases. In addition to determining census-tract-specific incidence ratios for each cancer type, a qualitative evaluation was conducted to determine whether any specific cancer type appeared to be concentrated in some area(s) or within any of the census tracts in Wayland.

Review of these data showed that there were no apparent spatial patterns of any specific cancer type at smaller geographic levels (i.e., neighborhoods) within the two census tracts in Wayland that was not likely attributed to the presence of a multi-unit complex, a nursing home, or more densely populated areas within the census tracts.

In addition, concerns have been raised regarding suspected increases in cancer incidence specifically in the neighborhoods of the Dow Chemical site located on Commonwealth Road in CT 3661. Review of the geographic distribution of cancer cases in this area did not reveal any unusual geographic pattern or clustering of any one cancer type. The cancer types that occurred in this area were different primary site cancers and no pattern was observed with respect to age, gender or year of diagnosis.

The former Dow Chemical site is located less than one-half mile north of the border between the towns of Wayland and Natick. Concerns have been expressed that contamination at the Dow

Chemical site may be related to the incidence of cancer in the surrounding area including the northwest portion of the town of Natick. The MDPH completed an evaluation of cancer incidence in Natick, MA (MDPH 1997b). The geographic distribution of cancer cases in the bordering census tract in Natick (CT 3821) was reviewed in relation to the Dow Chemical site. Again, review of this information did not reveal any concentrations or unusual pattern of any one cancer type in the Natick CT 3821 that borders the town of Wayland (MDPH 1997b).

D. Evaluation of Cancer Risk Factors

As previously mentioned, cancer is a term that describes a variety of diseases. As such, epidemiological studies have generally shown that different cancer types have separate causes, patterns of incidence, risk factors, latency periods (i.e., period between exposure and development of disease), characteristics and trends in survival (Shottenfeld and Fraumeni 1996). Available information related to factors known to be responsible for the development of cancer (e.g., smoking and occupation) were reviewed for the relevant cancer types described in this report.

1. Smoking Status

a. 1982-1992

Smoking is the most important known risk factor for cancers of the bladder, kidney, lung and pancreas. The smoking status of individuals in Wayland diagnosed with these cancers during the years 1982-1992 was reviewed. As shown in Figure 2A, with the exception of

kidney cancer, the majority of individuals diagnosed with these cancer types in Wayland were reported as current or former smokers.

Figures 3A and 3B present the distribution of cases with a known smoking status for each of the four cancer types evaluated in Wayland and the state. With the exception of kidney cancer, there were a greater number of current or former smokers in Wayland than individuals who reported never smoking. For lung cancer, among those who reported a smoking status, the majority of individuals (97%) were current or former smokers. Comparison of smoking status for kidney and
bladder cancer in Wayland and the state showed that the percent of current or former smokers was less in Wayland than in the state. The distribution of smoking status for pancreatic cancer among individuals in Wayland and the state was nearly equivalent.

b. 1987-1994

During the eight year period 1987-1994, the incidence of lung cancer was statistically significantly elevated among females in CT 3661 (19 cases were observed when 11 cases were expected; SIR=172). Smoking is the principal risk factor for the development of lung cancer. Therefore, the distribution of smoking status among female lung cancer cases in this census tract was reviewed and compared to the smoking status of female lung cancer cases in both Wayland as a whole and the state of Massachusetts. Review of smoking status information for female lung cancer cases in CT 3661 showed that the majority of cases (68%) were current or former smokers (refer to Figure 4). In addition, the distribution of current or former smokers among female lung cancer cases in Wayland was similar to that for female lung cancer cases in Massachusetts where 77% and 80% were current or former smokers.

2. Occupation

Occupational information as reported to the MCR was reviewed for cancer types that have been associated with exposures in specific occupations. This information was reviewed to

determine whether occupational factors might have contributed to the development of some cancers in Wayland. Occupation as reported to the MCR at the time of diagnosis was reviewed for cancer cases of the bladder, lung, pancreas, kidney, leukemia and NHL.

In general, review of this information did not reveal occupations that are known or suspected to be associated with the cancer types evaluated. Some individuals did report occupations that may have been associated with exposures suspected in the development of their disease. However, some cases reported to the MCR do not contain meaningful occupational information (e.g., occupation may be listed as "retired"). In other cases, no information is provided. The occupational data reported to the MCR for the majority of individuals is limited to job title or company name and
does not include specific job-duty information that could further define exposure potential. Therefore, the available information is generally not sufficient to determine whether occupational exposures may have occurred in some cases or what role occupation may have had in cancer incidence in the town of Wayland.

E. Evaluation of Breast Cancer Stage at Diagnosis, 1987-1994

The stage of cancer as reported to the MCR at the time of diagnosis was reviewed for breast cancer cases diagnosed between the years 1987-1994 in Wayland and each of it's two census tracts. Staging categorizes the extent of disease and its spread at the time of diagnosis. An evaluation of staging information can help determine whether cancer patients in a given area are being diagnosed at an early or late stage of the disease. This information can be used to determine the level of breast cancer screening taking place in a community. A high level of screening can lead to an increase in breast cancer incidence through better detection of early stage breast cancer. It is also important to examine the distribution of staging because breast cancer survival correlates strongly with a diagnosis of early stage cancer, especially with cancer limited to the breast (local or stage I) (ACS 1999).

This analysis defines stage in four categories: localized, regional, distant, or unknown. Localized breast cancer represents a diagnosis that the tumor is invasive but the cancer is

confined to the breast. Regional indicates that the tumor has spread beyond the organ of origin (breast). This may include spread to adjacent tissues or organs, lymph nodes or both. Distant indicates that the cancer has metastasized or spread to organs other than those adjacent to the organ of origin, or to distant lymph nodes or both (MCR 1996). Some of the cases reported to the MCR are reported with an unknown stage. This indicates that at the time of reporting the tumor had not been staged.

The distribution of the stage at diagnosis for female breast cancer cases in Wayland during 1987-1994 was similar to the distribution observed in Massachusetts as a whole (see Figure 6). In both Wayland and Massachusetts, a greater percentage of breast cancer cases were diagnosed at an early (i.e., local) stage than later stages of disease (i.e., regional and distant). As shown in Figure 6, 74% of the female breast cancer cases in Wayland were diagnosed at an early or local stage, while 21%
of cases were detected at later stages (20% regional and 1% distant). The stage of diagnosis was unknown for 5% of the breast cancer cases in Wayland.

Although in both Wayland and Massachusetts the majority of the female breast cancer diagnoses were at the local stage (74% in Wayland versus 62% in Massachusetts), Wayland showed 12% more local breast cancer diagnoses than the state during 1987-1994. In contrast, a greater percentage of breast cancer cases were diagnosed in Massachusetts at the regional and distant stages.

When stage at diagnosis was reviewed by census tract in Wayland, the majority (i.e., greater than 65%) of female breast cancer diagnoses in both census tracts was at the local stage (see Figure 7). However, although the majority of the female breast cancer diagnoses in both census tracts were at the local stage (68% in CT 3661 versus 77% in CT 3662), CT 3662 showed 9% more local breast cancer diagnoses than CT 3661 during 1987-1994. This increase in local diagnoses may be the result of greater use of screening services within this area of the town, and may help to explain the elevation in breast cancer incidence in this census tract and in the town of Wayland.